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(71) Applicant (for all designated States except US): **MOLD-MASTERS LIMITED** [CA/CA]; 233 Armstrong Avenue, Georgetown, Ontario L7G 4X5 (CA).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **GELLERT, Jobst** [CA/CA]; 125 Gloucester Avenue, Oakville, Ontario L6J 3W3 (CA).

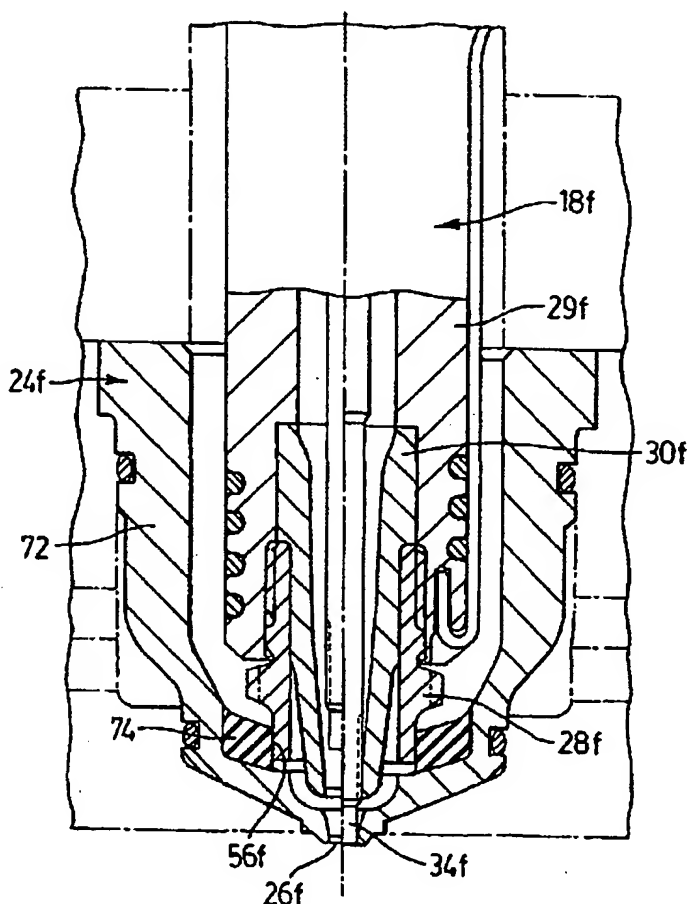
(74) Agents: **ROWAND, Fraser, D. et al.**; Ridout & Maybee LLP, One Queen Street East, Suite 2400, Toronto, Ontario M5C 3B1 (CA).

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[Continued on next page]

(54) Title: **MOLD GATE INSERT WITH A THERMAL BARRIER**



(57) Abstract: A mold gate insert (24f) includes a mold gate insert body, which is comprised of a material having a high thermal conductivity, and a thermal insulation element (74), which is nested in the mold gate insert body. The thermal insulation element (74) is provided to abut a nozzle seal (28f) and align the nozzle with a mold gate (34f). The amount of heat transferred from the nozzle to the mold gate insert (24f) is reduced by the thermal insulation element (74).



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## MOLD GATE INSERT WITH A THERMAL BARRIER

## FIELD OF THE INVENTION

The present invention relates generally to an injection molding apparatus, and in particular to mold gate insert for providing a thermal barrier between a mold gate and  
10 a nozzle tip.

## BACKGROUND OF THE INVENTION

In an injection molding apparatus, a manifold receives a pressurized melt stream of a moldable material from a machine nozzle. The manifold distributes the melt  
15 stream to a plurality of hot runner nozzles. Melt is injected from each nozzle through a mold gate and into a mold cavity where the melt is cooled to its "freezing" temperature, and then ejected from the mold cavity. The cycle is repeated so that multiple molded products may be produced.

The number of molded products that are output over a set time period is  
20 limited by the cycle time of the injection molding apparatus. The cycle time is determined by several factors, including the physical and chemical attributes of the resin, the size of the molded product, and the time required for the product to cool in the mold before it is ejected.

Reducing the cooling time of the molded product will reduce the overall cycle  
25 time. However, undesirable physical defects often result from attempts to reduce the cooling time, particularly in products, such as preforms, made from polyethylene terephthalate (PET). The most common of these undesirable characteristics are gate defects that occur in that portion of the preform in the vicinity of the gate. These common defects include crystalline halos and plugs, gate voids, internal dimples,  
30 scarred gates, and sticky or stringy gates. Many variables affect the quality of the gate area in a finished preform. Processing parameters, such as mold gate timing, nozzle tip temperature, and the flow rate of cooling fluid can all be adjusted to improve preform quality. However, insufficiently rapid heat transfer at the gate area remains one of the most persistent difficulties to overcome, and a continuing obstacle to greatly improved  
35 cycle times.

5           In a hot runner injection molding system with valve gating, the mold gate area is typically not cooled sufficiently. The mold gate is typically a tapered hole that is formed in a gate insert. A valve pin engages the mold gate to close the gate and prevent melt from flowing into the mold cavity. Because the mold gate is located between the high temperature nozzle tip and the mold cavity, heat is often undesirably  
10 transferred through the gate insert to the mold cavity. At the same time, the mold cavity quickly cycles between a high temperature when the gate is open to a low temperature sufficient to freeze the resin when the mold has been filled and the gate closed. The valve pin itself also transfers heat to the mold gate when the mold gate is closed. In order to lower the cycle time of the injection molding apparatus, it is desirable to  
15 thermally isolate the mold cavity from the nozzle tip.

Several prior art references disclose thermal shielding at the nozzle tip to limit cooling of the hot runner nozzle tip in the vicinity of the mold gate area.

U.S. Patent No. 6,220,850 discloses a mold gate insert that is formed of two pieces. A first portion of the insert forms a gate land and is made of an insulating  
20 material to thermally shield the nozzle. The second portion of the insert forms a section of the mold cavity and is made of a highly thermally conductive material. During the cooling phase of the injection cycle, the second portion provides rapid dissipation of heat to cool the mold cavity, while the first portion creates a thermal barrier to shield the nozzle tip from the cooling of the second portion.

25           U.S. Patent No. 5,879,727 discloses a thermal insulating element provided between a nozzle tip and a mold insert. The thermal insulating element limits the heat loss from the nozzle tip to the gate insert.

U.S. Patent No. 5,554,395 discloses a seal that is provided between a bushing, which delivers a melt stream to a mold cavity, and a mold, which houses the  
30 mold cavity. The seal closes off the gap between the bushing and the mold and limits the conduction of heat therebetween.

Some of the disadvantages of prior art tip insulation include insufficient thermal sealing of the nozzle tip in cases where the mold insert forms part of the mold cavity. In addition, prior art insulating devices are often complex to manufacture,  
35 particularly when more than one material is used.

It is therefore an object of the present invention to provide a mold gate insert

- 5 having a thermal barrier, which obviates or mitigates the above disadvantages.

### SUMMARY OF THE INVENTION

According to an aspect of the present invention there is provided an injection molding apparatus comprising:

- 10 a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;
- a nozzle having a nozzle tip and a nozzle channel, the nozzle channel being in communication with the manifold channel for receiving the melt stream from the manifold channel;
- 15 a seal coupled to the nozzle tip, the seal having an outer surface;
- a mold gate insert surrounding the nozzle tip, the mold gate insert including a mold gate to allow melt to travel from the nozzle channel into a mold cavity;
- a flange extending from an inner surface of the mold gate insert, a surface of the flange being in abutment with an outer surface of the seal;
- 20 a groove provided in the mold gate insert, the groove being located adjacent the flange; and
- wherein the groove decreases the amount of heat that is transferred to the mold gate insert through the flange.

- According to another aspect of the present invention there is provided an injection molding apparatus comprising:
- 25

- a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;
- a nozzle having a nozzle tip and a nozzle channel, the nozzle channel being in communication with the manifold channel for receiving the melt stream from the manifold channel;
- 30 a seal coupled to the nozzle tip, the seal having an outer surface;
- a mold gate insert surrounding the nozzle tip, the mold gate insert including an inner surface for abutting the outer surface of the seal and a groove that is spaced from the inner surface;
- 35 a mold gate provided in the mold gate insert to allow melt to flow from the

- 5 nozzle channel into a mold cavity; and  
wherein the groove decreases the amount of heat that is transferred to the mold gate insert through the flange.

According to another aspect of the present invention there is provided an injection molding apparatus comprising:

- 10 a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;  
an injection nozzle having a nozzle body and a nozzle tip, the nozzle tip being surrounded by a nozzle seal, the injection nozzle having a nozzle channel for receiving a melt stream of moldable material from the manifold channel;  
15 a mold gate insert having a first portion and a second portion, the second portion being nested in the first portion and spaced from a mold gate to align the nozzle seal within the mold gate insert, the second portion being comprised of a thermally insulating material;  
a mold gate provided in the mold gate insert to allow melt to flow from the nozzle  
20 channel into a mold cavity; and  
wherein the second portion provides insulation between the first portion of the mold gate and the nozzle seal.

According to yet another aspect of the present invention there is provided a mold gate insert comprising:

- 25 a mold gate insert body comprised of a material having a high thermal conductivity;  
a mold gate provided in the mold gate insert body for allowing a melt stream to flow into a mold cavity; and  
a thermal insulation element nested in the mold gate insert body, the thermal  
30 insulation element for abutting a nozzle seal of a nozzle to align the nozzle with the mold gate.

According to another aspect of the present invention there is provided an injection molding apparatus comprising:

- a manifold having a manifold channel for receiving a melt stream of moldable  
35 material under pressure;

5 an injection nozzle having a nozzle body and a nozzle tip, the nozzle tip being surrounded by a nozzle seal, the injection nozzle having a nozzle channel for receiving a melt stream of moldable material from the manifold channel;

a mold gate insert having a thermal insulation element nested in a mold gate insert body, the mold gate insert having a nozzle seal alignment surface for abutting an  
10 outer surface of the nozzle seal;

a mold gate provided in the mold gate insert to allow melt to flow from the nozzle channel into a mold cavity;

wherein the thermal insulation element provides insulation between the mold gate insert body and the nozzle seal.

15 The present invention provides an advantage in that the thermal insulation element reduces the amount of heat transferred from the nozzle to the mold gate insert. The present invention provides a further advantage in that the seal is aligned within the mold gate insert.

## 20 BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a side sectional view of an injection molding apparatus of the present invention;

25 Figure 2 is a side sectional view of portions of an injection molding apparatus of the present invention;

Figure 3 is an enlarged view of portions of Figure 2;

Figure 4 is a side sectional view of a mold gate insert of the present invention;

30 Figure 5 is a side sectional view of a further embodiment of an injection molding apparatus of the present invention;

Figure 6 is an enlarged view of portions of Figure 5;

Figure 7 is a further embodiment of a mold gate insert of the present invention;

35 Figure 8 is a side sectional view of two further embodiments of a mold

5 gate insert of the present invention;

Figure 9 is a side sectional view of a further embodiment of a mold gate insert of the present invention;

Figure 10 is a side sectional view of yet a further embodiment of a mold gate insert of the present invention;

10 Figure 11 is an enlarged view of the mold gate insert of Figure 10;

Figure 12 is side sectional view of still a further embodiment of a mold gate insert of the present invention; and

Figures 13 (i) and (ii) are both side sectional views of a nozzle with a mold gate insert of the present invention.

15

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1, an injection molding apparatus is generally shown at 10. The injection molding apparatus 10 comprises a manifold 12 having a manifold melt channel 14 for receiving a melt stream of moldable material under pressure from a manifold bushing 16. The manifold bushing 16 is in communication with a machine nozzle (not shown).

Nozzles 18 are coupled to respective outlets 20 of the manifold 12. A nozzle channel 22 extends through each nozzle 18 for receiving the melt stream of moldable material from the manifold 12. Each nozzle 18 includes a nozzle body 29 and a nozzle tip 30. Manifold heaters 36 and nozzle heaters 38 heat the manifold 12 and nozzles 18 respectively in order to maintain the melt stream at a high temperature. A mold gate 26 is provided in a mold gate insert 24, which generally surrounds the tip 30 of each nozzle 18. The mold gates 26 are openable to allow delivery of the melt stream to respective mold cavities 32. A valve pin 34 extends through the length of each nozzle 18 and is movable by a valve piston 36 to open and close the mold gate 26.

Cooling channels 40 are provided adjacent the mold gate inserts 24 and the mold cavities 32 in order to facilitate cooling of the melt in the mold cavities 32. The mold gate insert 24 is typically comprised of a highly thermally conductive material such as copper, for example. The high thermal conductivity of the mold gate insert 24 allows the mold gate 26 to be cooled rapidly so as to freeze the melt in the mold gate area. This minimizes the occurrence of drooling from the nozzle 18. In order to minimize the



5 heat transfer between the insert 24 and the nozzle 18, an insulation chamber 42 is provided between the mold gate insert 24 and the nozzle 18. The insulation chamber 42 is typically filled with air.

A seal 28 is provided between the nozzle 18 and mold gate insert 24. The seal 28 is comprised of a thermally insulating material, such as steel or titanium, for  
10 example. The seal 28 restricts the back flow of melt so that the melt does not enter the insulation chamber 42. In addition, the seal 28 acts to minimize the heat transfer between the mold gate insert 24 and the nozzle tip 30.

As shown in Figures 2 and 3, the lower end of the seal 28 abuts a mating  
15 surface 56 of a flange 46, which projects from an inner wall 48 of the mold gate insert 24. The flange 46 locates the seal 28 in the mold gate insert 24 so that the nozzle 18 is properly aligned with the mold gate 26. A bubble area 60 is located between the seal 28, mold gate 26 and the nozzle tip 30. The bubble 60 is filled with melt, which becomes solid when the mold gate 26 is frozen. A water cooling cavity 52 surrounds the mold gate insert 24 to facilitate freezing thereof. Seals 54 are employed to prevent  
20 water from escaping from the cavity 52. The nozzle assembly of Figures 2 and 3 further includes a thermocouple 50.

Figure 4 is an enlarged view of the mold gate insert 24. A groove 44 is formed in the inner wall 48 of the mold gate insert 24 and is located adjacent the flange 46. The groove 44 is continuous and generally concentric with an axis 45 of the mold  
25 gate 24. The groove 44 extends the insulation chamber 42 so the thickness of the mold gate 24 between the inner wall 48 of the insulation chamber 42 and the outer wall of the mold gate insert 24 is reduced.

It will be appreciated that the groove 44 may be offset from the axis of the mold gate 26 and in addition, the groove 44 is not restricted to following a circular path.  
30 In an alternative embodiment, the groove 44 comprises a series of segments that are spaced in a generally circular path in the inner wall 48 of the mold gate insert 24. In a further alternative embodiment, the groove 44 comprises a series of holes that are spaced along a path in the inner wall 48. In a still further alternative embodiment, the path of the groove 44 zig zags.

35 During the cooling stage of the injection molding cycle, water flows through cavity 52 to cool the mold gate insert 24 and the cooling channels 40 cool the mold

5 cavity 32. The mold gate 26 and the melt located in the bubble area 60 freezes.

To reduce cycle time, it is desirable to freeze and subsequently heat the melt in the mold gate 26 as quickly as possible. The insulation chamber 42 reduces the heat transfer between the mold gate insert 24, which is cooled, and the nozzle 18, which is heated. The groove 44 reduces the amount of heat that is transferred directly from the seal 28, which is in contact with the nozzle 18, to the mold gate insert 24. The flange 46 acts as a heat transfer fin providing increased surface area to dissipate the heat more efficiently.

Referring to Figures 5 and 6, a further embodiment of the present invention is shown. A nozzle 18a is a torpedo-type hot runner nozzle, which uses a thermal gating mechanism. A nozzle tip 30a of the nozzle 18a extends into a mold gate 26a of a mold gate insert 24a. Once the mold cavity (not shown) has been filled with melt, the melt in the mold gate 26a is frozen in order to block the mold gate 26a and thus prevent drooling from the nozzle 18a. The mold gate insert 24a has been previously described in relation to Figures 2, 3 and 4 and provides the same thermal insulating advantages as has been previously described.

Referring to Figure 7, a further embodiment of a mold gate insert 24b is shown. In this embodiment, a groove 44b has a generally rectangular profile and is filled with an insulating material 62 such as a ceramic paste, for example. As shown, the groove 44b is slightly larger than the groove 44 of the previous figures.

It will be appreciated by a person skilled in the art that a larger groove will provide increased insulation capability, however, the size of the groove is limited by the structural requirements of the mold gate insert 24.

Further embodiments of a mold gate insert 24c and 24d are shown in Figure 8. Embodiment (i) includes a pocket 64 that has an open side 66. The seal 28c abuts the open side 66 of the pocket 64 to seal air inside. Alternatively, there may not be a complete seal formed between open side 66 and seal 28 so that melt may leak into the pocket 64. The melt would also act as an insulator.

Embodiment (ii) of Figure 8 includes a pocket 68 that is provided between an inner wall 48c of the mold gate insert 24 and a second insert portion 70. The pocket 68 may be filled with air or, alternatively, a ceramic insulating material. The second insert portion 70 may be comprised of the same thermally conductive material as the mold

5 gate insert 48c or it may also be different. The second insert portion 70 may alternatively be made of a less thermally conductive material.

Referring to Figure 9, still a further embodiment of a mold gate insert 24e is shown. In this embodiment, seal 28e abuts a smaller portion of mating surface 56e of flange 46e so that melt may fill the space provided between the seal 28e and the mating  
10 surface 56e and act as an insulator.

A further embodiment of a mold gate insert 24f is shown in Figure 10. A nozzle 18f, which includes a nozzle body 29f and a nozzle tip 30f, extends through the mold gate insert 24f to deliver melt through a mold gate 26f and into a mold cavity (not shown). The valve gate 26f is selectively openable by a valve pin 34f that extends  
15 through the nozzle 18f. A seal 28f is provided between the nozzle tip 30f and the mold gate insert 24f. Other components of the injection molding apparatus are similar to those described in relation to Figures 1-3.

The mold gate insert 24f, which is shown in Figure 11, includes a thermal insulation element 74 that is nested within a mold gate insert body 72. The thermal  
20 insulation element 74 includes an inner wall 56f that abuts the seal 28f. The thermal insulation element 74 is comprised of an insulating material, which has a lower thermal conductivity than the material of the mold gate insert body 72. The thermal insulation element 74 may be comprised of materials such as Vespel, ceramic, PEK or titanium, for example.

25 The inner wall 56f of the thermal insulation element 74 aligns the seal 28f within the mold gate insert 24f. This allows the nozzle 18f to be aligned with the mold gate 26f so that the valve pin 34f may operate efficiently. The thermal insulation element 74 further serves to insulate the mold gate insert 24f from the nozzle 18f.

Referring now to Figure 12, a nozzle 18g includes a nozzle body 29g, a  
30 nozzle tip 30g and a valve pin 34g, which extends through the nozzle 18g. The seal 28, which has been shown in the previous figures, has been integrated into the nozzle tip 30g. A mold gate insert 24g includes a mold gate 26g, which is aligned with the nozzle 18g to allow melt to pass therethrough into a mold cavity (not shown). The mold gate insert 24g is similar to the mold gate insert 24f of Figures 10 and 11 and includes a mold  
35 gate insert body 72g and a thermal insulation element 74g. An inner wall 56g of the mold gate insert 24g abuts the nozzle tip 30g to provide a seal therebetween.

5           It will be appreciated by a person skilled in the art that the mold gate inserts described herein may be used with any nozzle having a nozzle seal surrounding a tip thereof. Figure 13 is divided into (i) and (ii) to show two different mold gate inserts surrounding a nozzle 18h. Figure 13 (i) shows the nozzle 18h surrounded by a mold gate insert 24h that is similar to the mold gate insert 24f of Figures 10 and 11. Figure  
10   13 (ii) shows the nozzle 18h surrounded by a mold gate insert 24hh, which is similar to the mold gate insert 24 shown in Figures 2-6.

          The nozzle 18h includes an integral nozzle tip 30h and nozzle seal 28h. When assembled in an injection molding apparatus, an outer surface 76 of the nozzle 18h abuts the inner wall 56h, 56hh of the mold gate inserts 24h and 24hh, respectively,  
15   to provide a seal therebetween. It will be appreciated by a person skilled in the art that the nozzle 18h may be used with any of the mold gate insert embodiments that have been previously described.

          The many features and advantages of the invention are apparent from the detailed  
20   specification and, thus, it is intended by the appended claims to cover all such features and advantages of the invention that fall within the true spirit and scope of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly all suitable modifications and equivalents may  
25   be resorted to, falling within the scope of the invention.

## CLAIMS

What is claimed is:

1. An injection molding apparatus comprising:
  - a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;
  - a nozzle having a nozzle tip and a nozzle channel, said nozzle channel being in communication with said manifold channel for receiving the melt stream from said manifold channel;
  - a seal coupled to said nozzle tip, said seal having an outer surface;
  - a mold gate insert surrounding said nozzle tip, said mold gate insert including a mold gate to allow melt to travel from said nozzle channel into a mold cavity;
  - a flange extending from an inner surface of said mold gate insert, a surface of said flange being in abutment with an outer surface of said seal;
  - a groove provided in said mold gate insert, said groove being located adjacent said flange;
  - wherein said groove decreases the amount of heat that is transferred to said mold gate insert through said flange.
2. An injection molding apparatus as claimed in claim 1, wherein said nozzle tip and said nozzle seal are integral with said nozzle.
3. An injection molding apparatus as claimed in claim 1, wherein an insulating material is located in said groove.
4. An injection molding apparatus as claimed in claim 3, wherein said insulating material is a ceramic paste.
5. An injection molding apparatus comprising:
  - a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;

a nozzle having a nozzle tip and a nozzle channel, said nozzle channel being in communication with said manifold channel for receiving the melt stream from said manifold channel;

a seal coupled to said nozzle tip, said seal having an outer surface;

a mold gate insert surrounding said nozzle tip, said mold gate insert including an inner surface for abutting said outer surface of said seal and a groove that is spaced from said inner surface;

a mold gate provided in said mold gate insert to allow melt to flow from said nozzle channel into a mold cavity;

wherein said groove decreases the amount of heat that is transferred to said mold gate insert through said flange.

6. An injection molding apparatus as claimed in claim 5, wherein an insulating material is located in said groove.

7. An injection molding apparatus as claimed in claim 6, wherein said insulating material is a ceramic paste.

8. An injection molding apparatus comprising:

a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;

an injection nozzle having a nozzle body and a nozzle tip, said nozzle tip being surrounded by a nozzle seal, said injection nozzle having a nozzle channel for receiving a melt stream of moldable material from said manifold channel;

a mold gate insert having a first portion and a second portion, said second portion being nested in said first portion and spaced from a mold gate to align said nozzle seal within said mold gate insert, said second portion being comprised of a thermally insulating material;

a mold gate provided in said mold gate insert to allow melt to flow from said nozzle channel into a mold cavity;

wherein said second portion provides insulation between said first portion of said mold gate and said nozzle seal.

9. An injection molding apparatus as claimed in claim 8, wherein said thermally insulating material is selected from the group consisting of: Vespel, ceramic, PEK and titanium.
10. A mold gate insert comprising:  
a mold gate insert body comprised of a material having a high thermal conductivity;  
a mold gate provided in said mold gate insert body for allowing a melt stream to flow into a mold cavity;  
a thermal insulation element nested in said mold gate insert body, said thermal insulation element for abutting a nozzle seal of a nozzle to align said nozzle with said mold gate.
11. A mold gate insert as claimed in claim 10, wherein said thermal insulation element is comprised of a different material than said melt stream.
12. An injection molding apparatus comprising:  
a manifold having a manifold channel for receiving a melt stream of moldable material under pressure;  
an injection nozzle having a nozzle body and a nozzle tip, said nozzle tip being surrounded by a nozzle seal, said injection nozzle having a nozzle channel for receiving a melt stream of moldable material from said manifold channel;  
a mold gate insert having a thermal insulation element nested in a mold gate insert body, said mold gate insert having a nozzle seal alignment surface for abutting an outer surface of said nozzle seal;  
a mold gate provided in said mold gate insert to allow melt to flow from said nozzle channel into a mold cavity;  
wherein said thermal insulation element provides insulation between said mold gate insert body and said nozzle seal.
13. An injection molding apparatus as claimed in claim 12, wherein said thermal

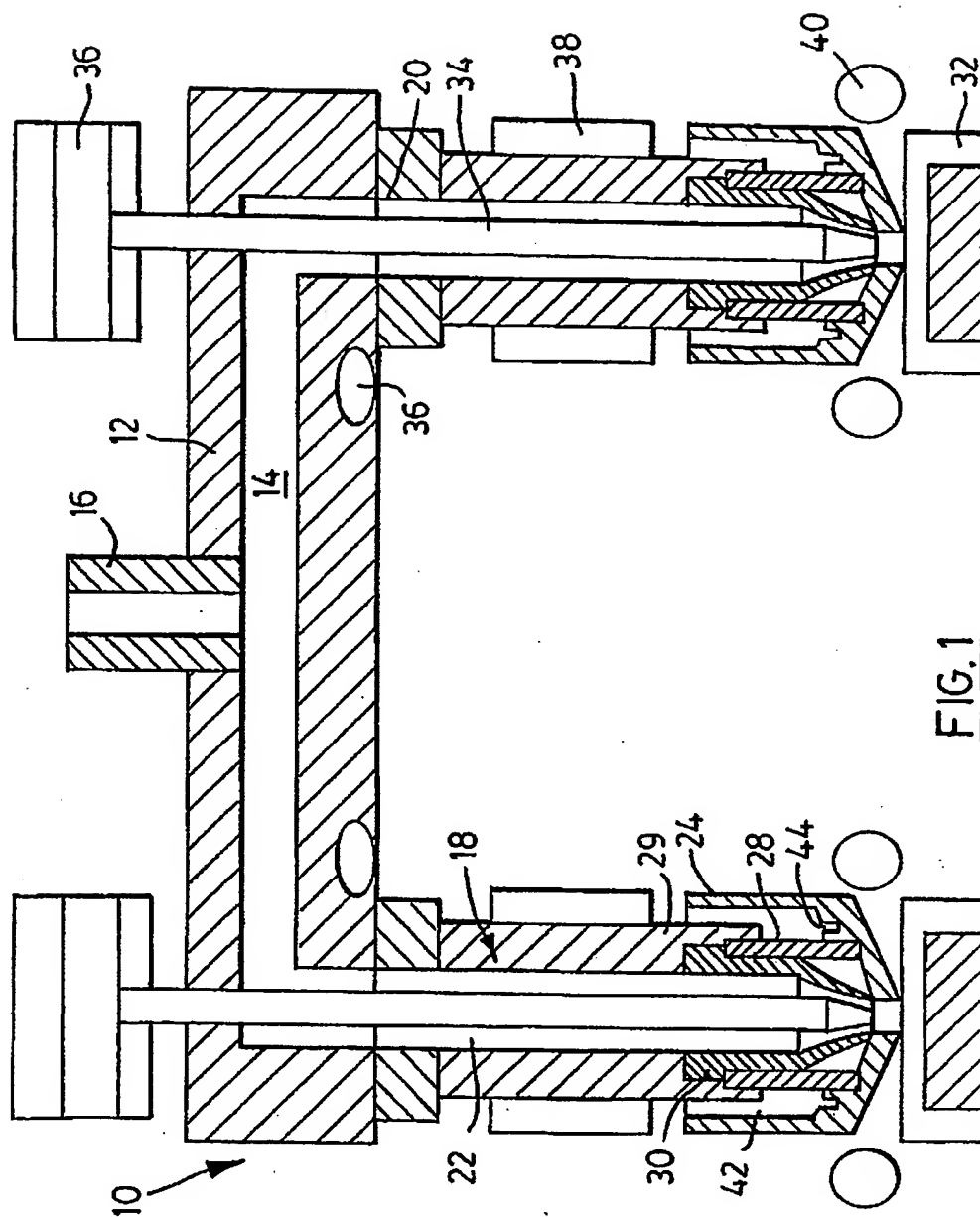
insulation element is a sleeve and an inner surface of said sleeve is said nozzle alignment surface.

14. An injection molding apparatus as claimed in claim 13, wherein a material of said thermal insulation element is selected from the group consisting of: Vespel, ceramic, PEK and titanium.

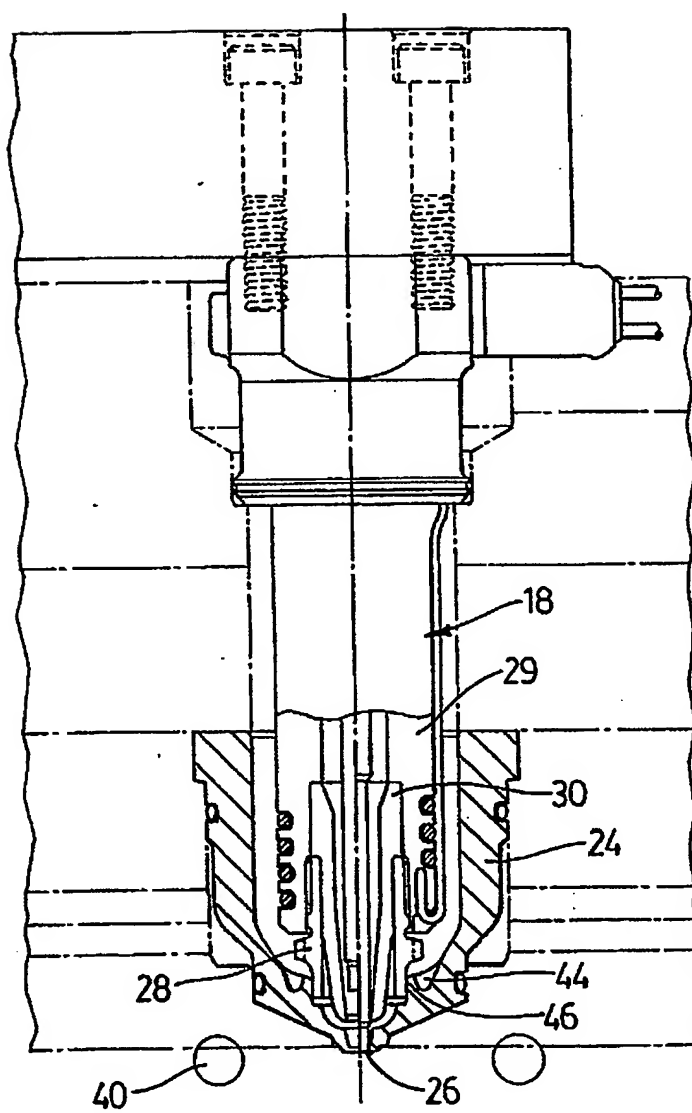
15. An injection molding apparatus as claimed in claim 12, wherein said thermal insulation element is a groove, said groove being spaced from said nozzle alignment surface.



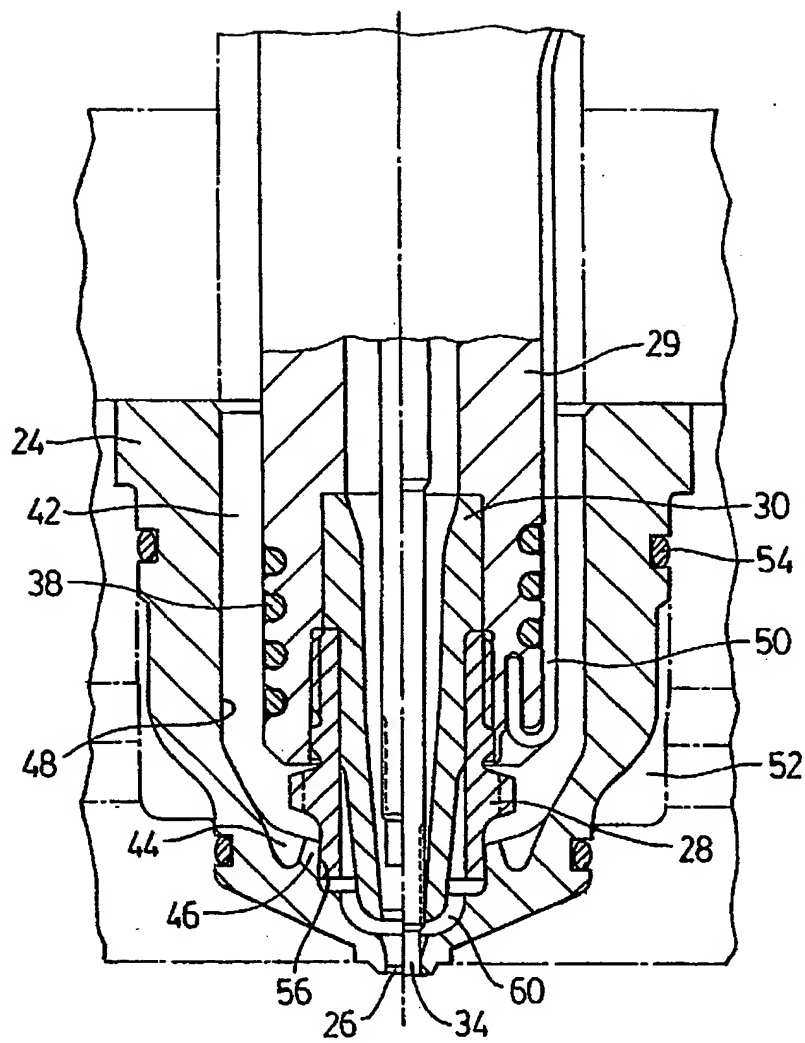
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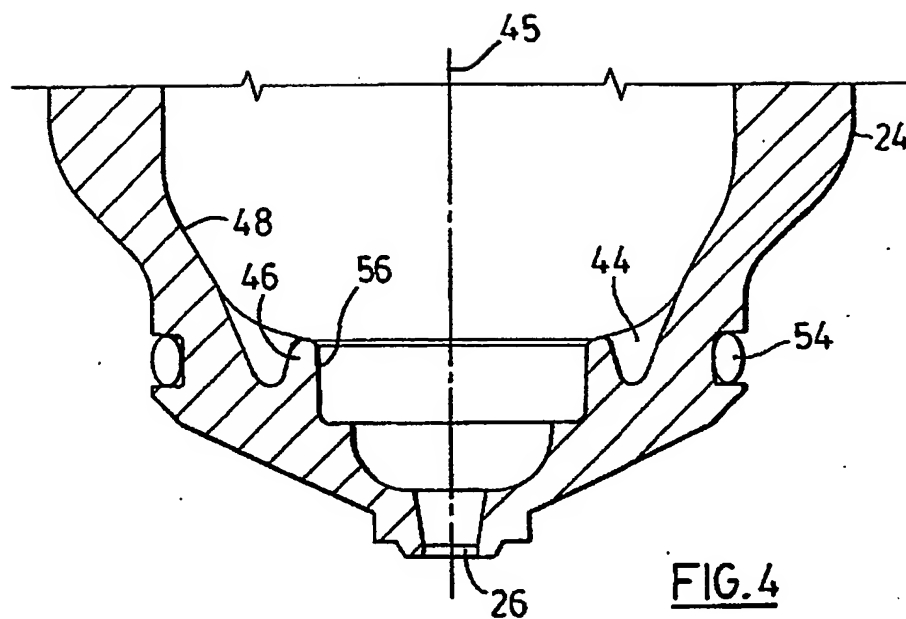
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**FIG. 2**

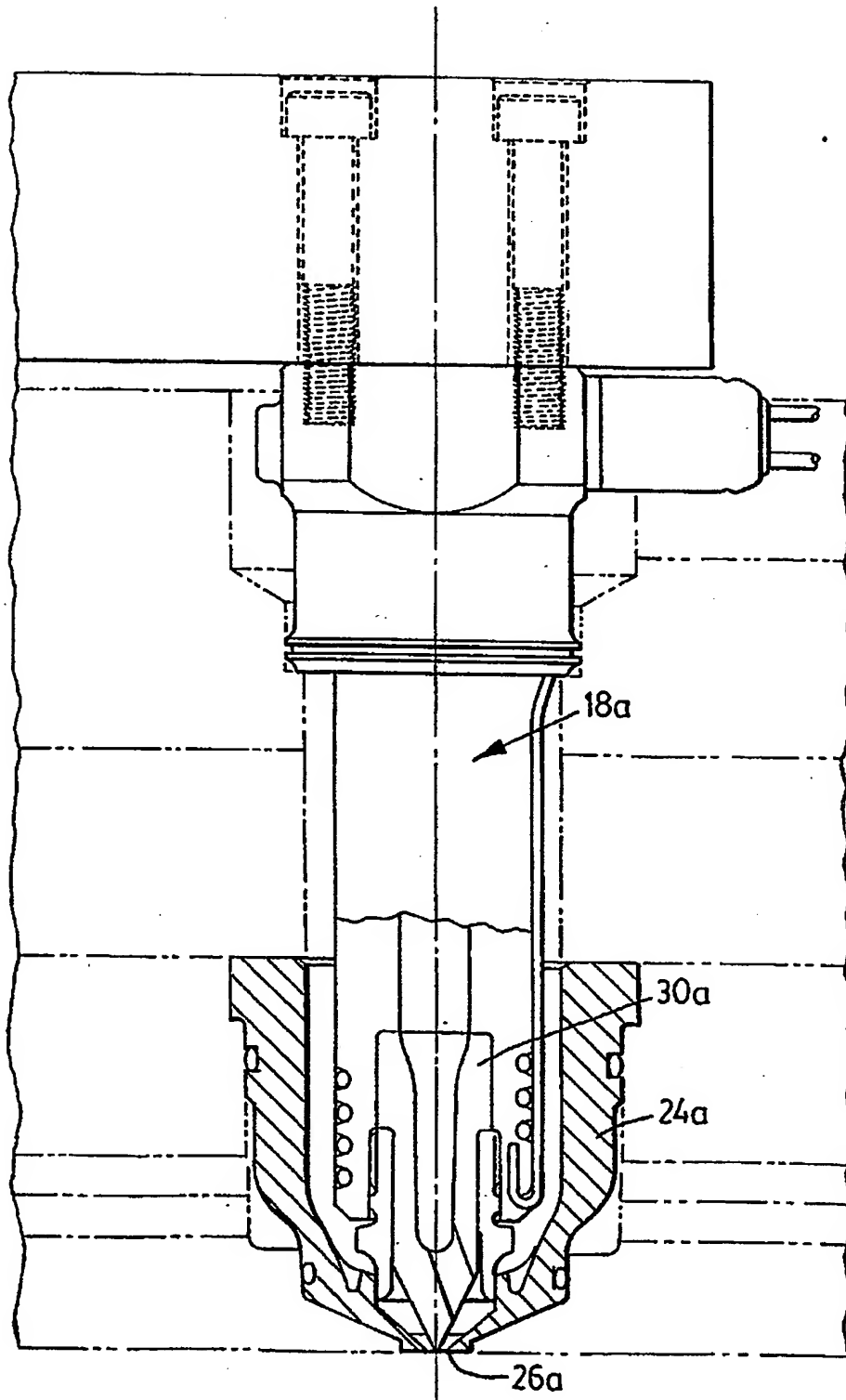
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**FIG. 3**

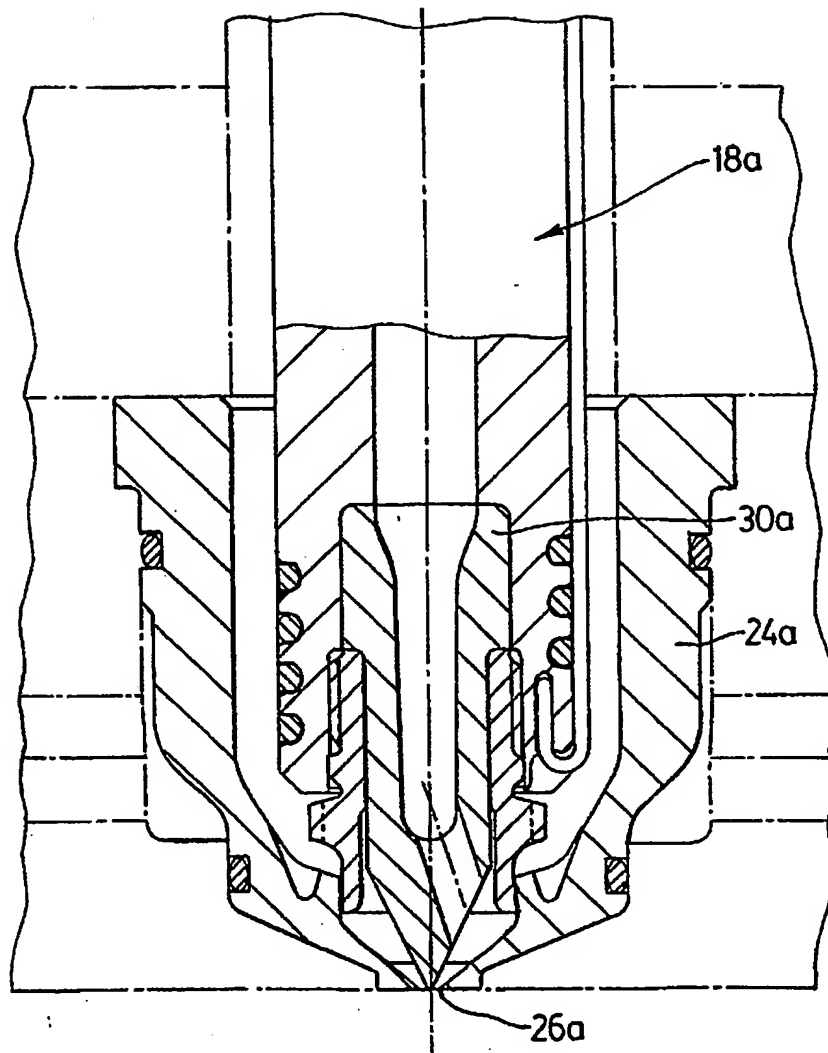
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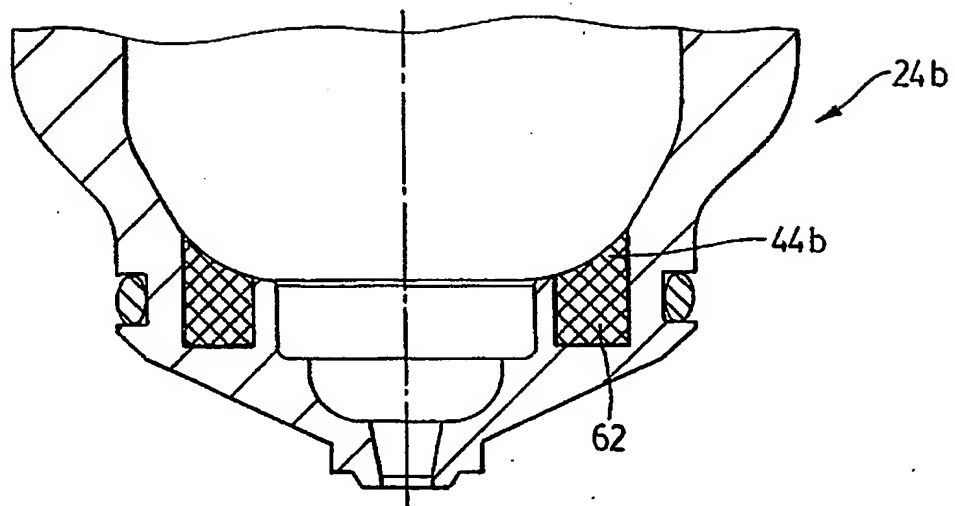
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FIG. 5

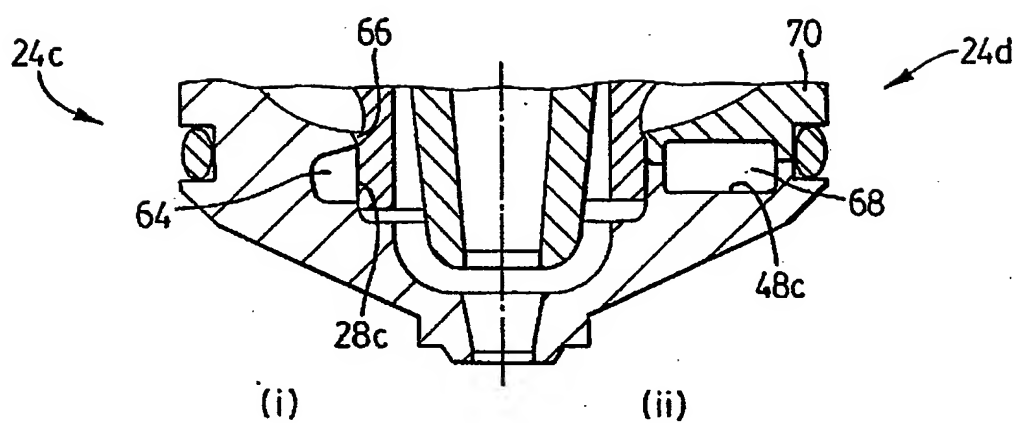
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FIG. 6

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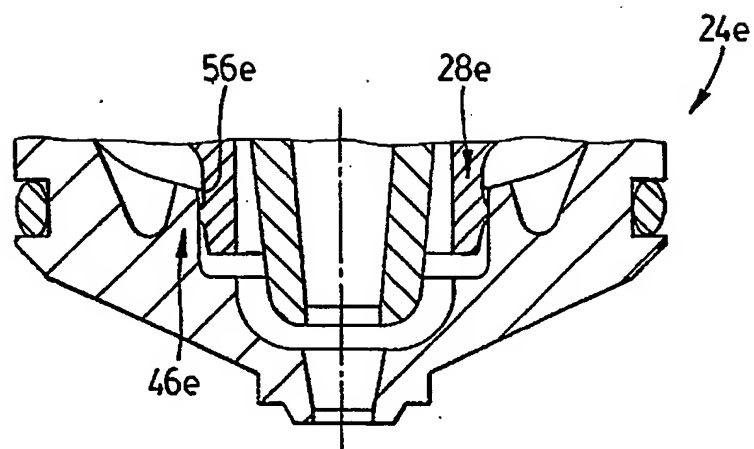
FIG. 7

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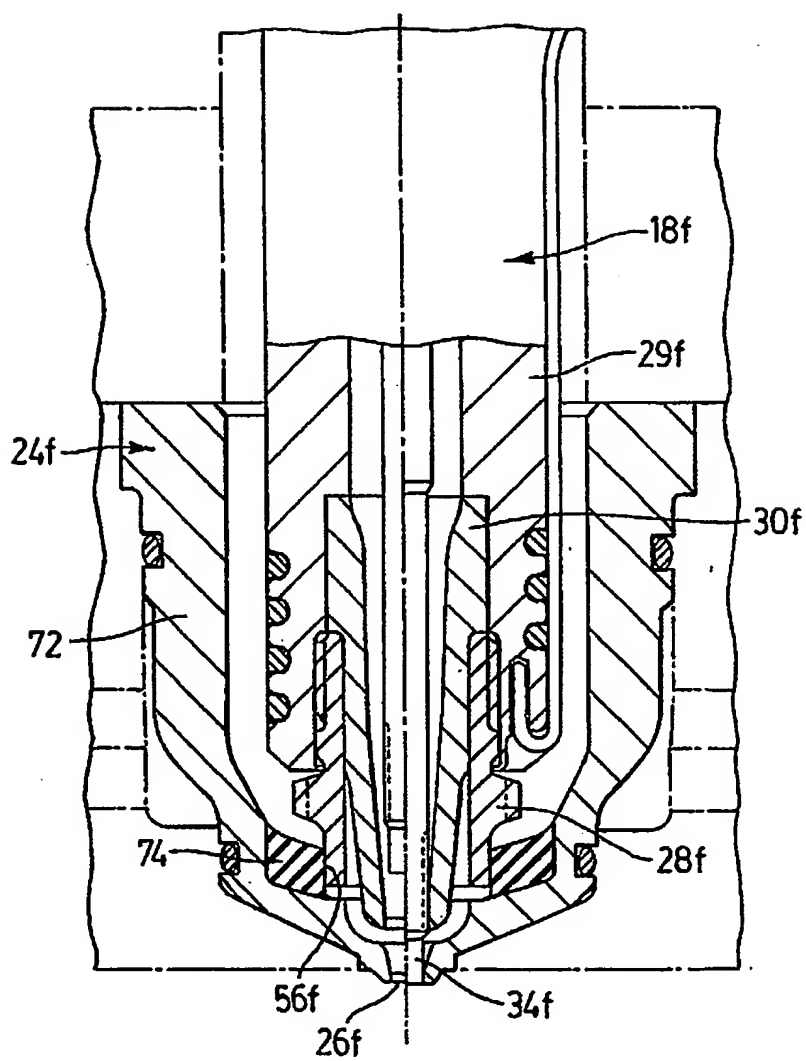
FIG. 8



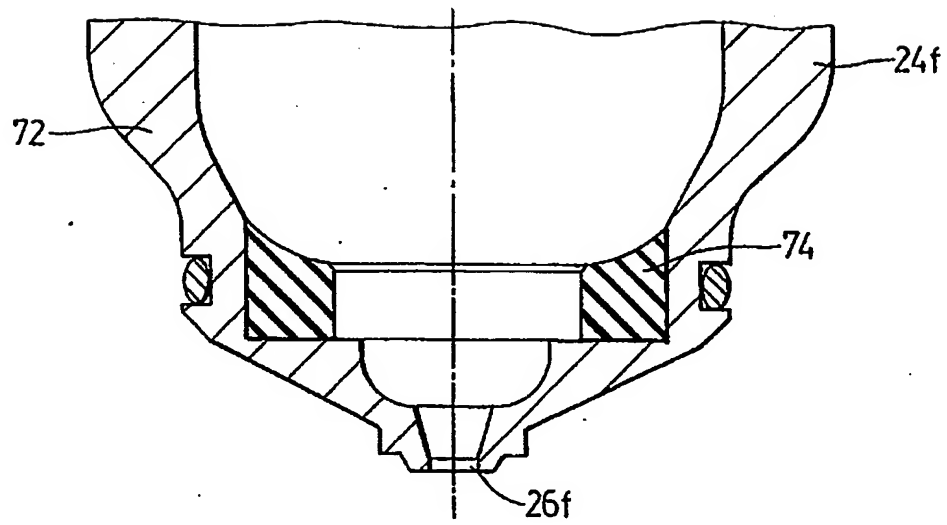
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FIG. 9

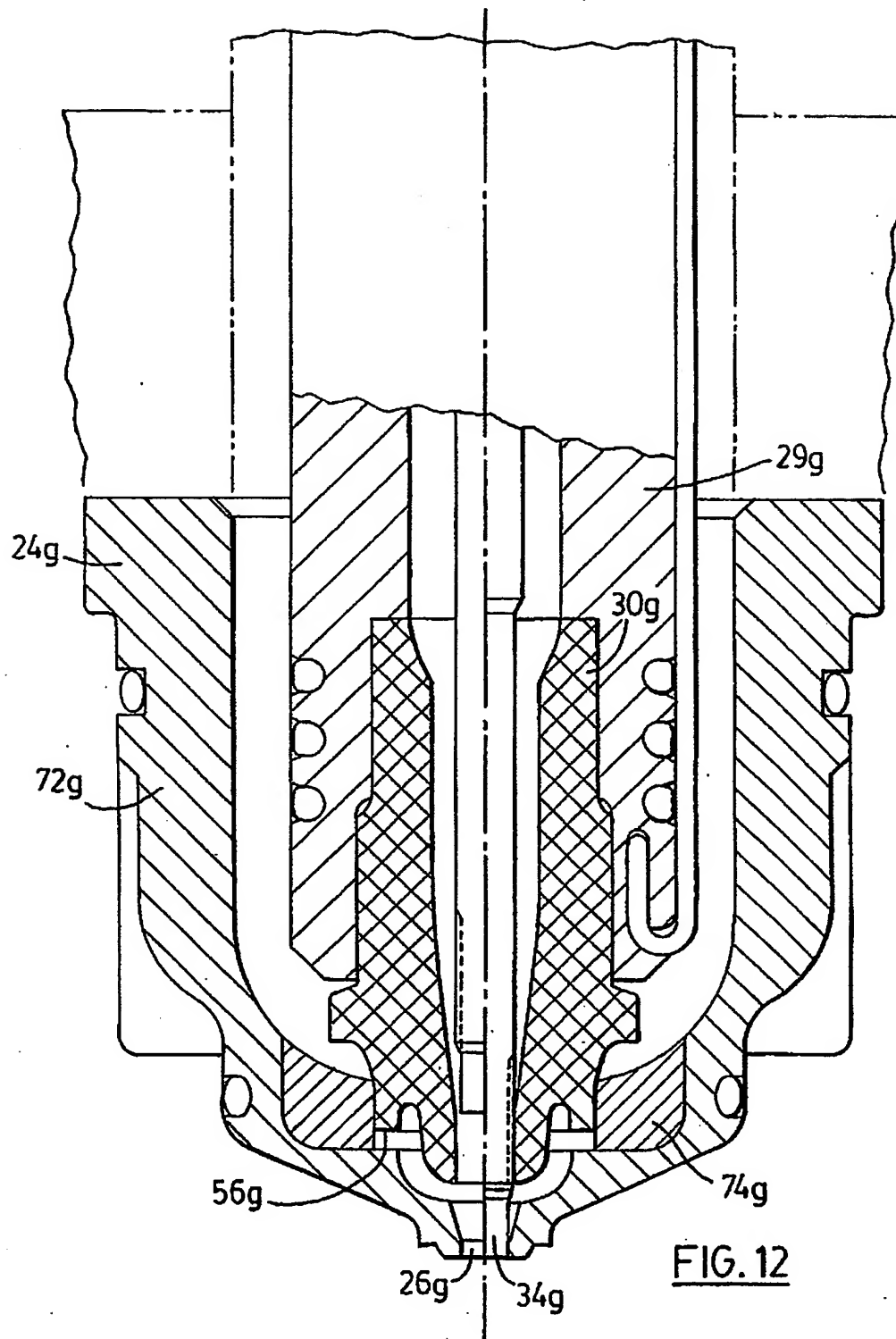
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FIG. 10

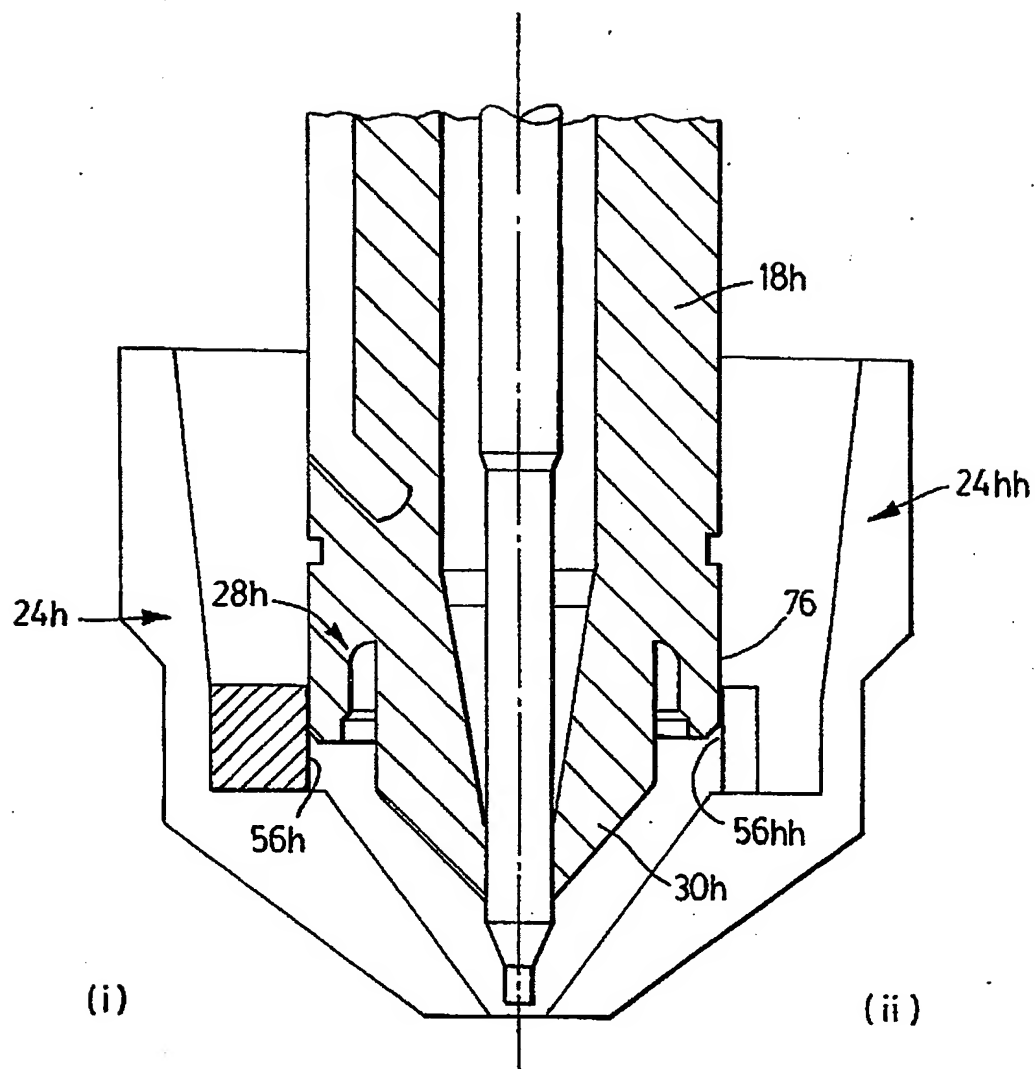
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FIG. 11

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FIG. 12

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FIG. 13

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B29C45/27

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	the whole document	8,10-12
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	figure 2	
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

8 July 2003

Date of mailing of the international search report

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Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
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